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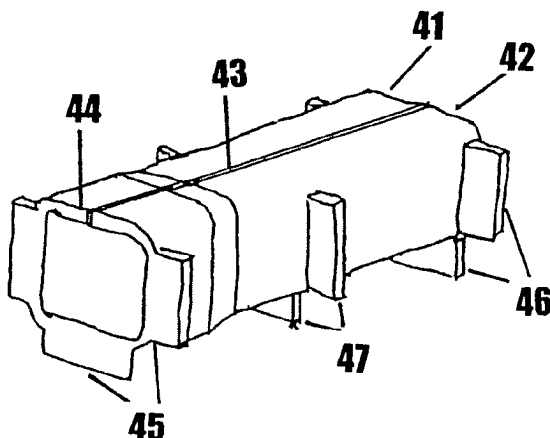
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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: METHOD OF MANUFACTURING STRUCTURAL MEMBERS AND THE MEMBERS PROVIDED BY SUCH METHOD



(57) Abstract: Energy absorbing structural member provided as an integral one-piece member exhibiting variation in wall thickness provided by a manufacturing method comprising steps of extruding an open shape, bending it along the major axis into a final cross-sectional configuration and finally closing the shape along abutted walls by welding operation.

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## "Method of manufacturing structural members and the members provided by such method"

The present invention relates to a method of manufacturing energy absorbing structural members having closed cross-sectional configuration, and more particularly to manufacturing of crash boxes in (motor) vehicles, and also the members provided by such method.

Presently such structural members are provided by a conventional extrusion process (particularly members made of Al or Al-alloys), extruding closed shapes of the required cross-sectional configuration and uniform wall thickness in their longitudinal extension in one production step.

However, there are several disadvantages connected to the present conventional manufacturing method of such members. First of all, due to the limitations inherent to the extrusion process a lower extruding speed and increased die wear are typical for providing (intricate) closed shapes compared to provision of open ones.

Furthermore, it is not possible to provide shapes exhibiting variation along their longitudinal extension, and there is a limit with regard to a maximum achievable diameter (cross-sectional area) of the provided shape (members). Consequently, in order to meet various requests to specific performance of the actual structural members and/or cope with the limited available space left for the member it is necessary to reshape the members and reinforce/strengthen them on pre-determined locations.

It is therefore an object of the present invention to provide a new method of manufacturing energy absorbing structural members offering more flexibility with regard to their cross-sectional configuration and no limitation of the maximum diameter of the resulting members.

A further object of the present invention is to provide novel energy absorbing structural members exhibiting variations in their wall thickness in the direction of their longitudinal extension comprising integrated additional parts.

These and other objects are achieved in accordance with the present invention by provision of a novel manufacturing method and the resulting structural members as it appears from the attached patent claims 4 and 1.

Specific novel features and advantages of the structural members provided by the manufacturing method according to the invention will be apparent from the following detailed description of preferred embodiment(s) of the structural member with reference to the accompanying drawings, Figs. 1-4, where

Fig. 1 shows schematically in a perspective view an extruded open shape,

Figs. 2-3 illustrate in a perspective view subsequent steps of material removing and reshaping/folding of the shape, and

Fig. 4 shows schematically the formed closed shape member being joined along abutted longitudinally extending folded walls.

Referring to Figures 1-4 illustrating by the way of example steps in the novel manufacturing process of a crash box according to the present invention, Figure 1 is a perspective view of an open shape 1 being conventionally provided by extrusion process, or alternatively by drawing of aluminium alloy material. The open

shape is extruded with protruding ribs 11,12, representing a material buffer for consequent steps of reshaping and so does the thicker wall part 13 extending longitudinally in the extrusion direction as indicated in Figure 1.

Figure 2 illustrates schematically the second step of the manufacturing method - cutting of excess material from the protruding ribs 11,12, thus providing several vertically protruding parts 22,23.

Figure 3 schematically illustrates a first step in the process of bending/reshaping along the longitudinal extension of the energy absorbing member to be, showing formation of a side wall and top wall where the top wall at the same time provides a joining seam line 31 to be abutted to the corresponding seam line 32 after finishing the bending operation. The buffer material from the thicker wall part 33, originally extruded in the longitudinal extrusion direction, is advantageously applied in providing thicker parts situated in front of the formed member and in plan normal to the extruding direction. Thus this novel method of manufacturing allows to provide the excess material in areas needed for formation of e.g. fastening flanges, reinforcing ribs etc. as illustrated in Figure 4.

Figure 4 illustrates schematically in a perspective view the ready folded hollow energy absorption member where the abutted opposing walls 41,42 are joined together along the joining line 43, preferentially by the new welding process so-called friction stir welding, resulting in no thermal distortion of the welded member.

As it appears from Figure 4 the novel integral one-piece energy member, in this particular case a crash box member, is provided with front part 44 exhibiting increased wall thickness. Furthermore, provision of the integrated flanges 45 simplifies construction and facilitates assembling, thus reducing both time and cost of the assembling operations.

Additionally several protruding parts can be provided, e.g. the shown attachment flanges 46 integrated with the rear part of the crash box and reinforcing ribs 47 or means for e.g. fastening towing hooks (not shown in the Figure).

Although the present invention has been described and illustrated with respect to the preferred features/embodiments and manner of manufacturing, it is to be understood that various changes and modifications may be made to the specifically described and illustrated arrangement without departing from the scope of the present invention.

Thus, e.g. the actual energy absorbing structural member provided by the novel manufacturing method could be a (front/rear) side member in the space frame construction of vehicles. Furthermore, other cross-sectional configurations than the shown rectangular one can advantageously be provided by means of the novel manufacturing method.

Claims

1. Energy absorbing structural member, particularly a crash box or side member in a vehicle frame structure comprising a closed shape (1) of any suitable cross-sectional configuration  
characterized in that  
the member is an integral one-piece member exhibiting variation in wall thickness being further provided with integrated protruding parts (45,46,47), said parts having additional performance functions.
2. Energy absorbing member according to claim 1,  
characterized in that  
the members are extruded and where the integrated parts are laterally extending attachment flanges (45,46).
3. Energy absorbing member according to claim 1 or 2,  
characterized in that  
the (extruded) member is made of aluminium alloy.
4. Method of manufacturing the energy absorbing member according to claim 1, the method comprising steps of
  - extruding an open shape exhibiting varied wall thickness across its lateral extension, removing of excess material/cutting
  - bending of the shape along the major axis into a final configuration of the energy absorbing member including additional functional parts, and finally
  - closing the shape by bending and abutting of opposing walls and joining of the thus abutted walls by any joining technique known per se.

5. Method according to claim 4,  
characterized in that  
the joining is done by a welding operation.
6. Method according to claim 5,  
characterized in that  
the welding operation is friction stir welding.

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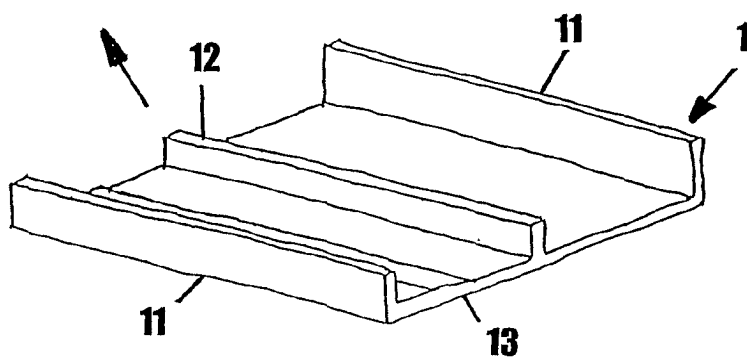


Fig. 1

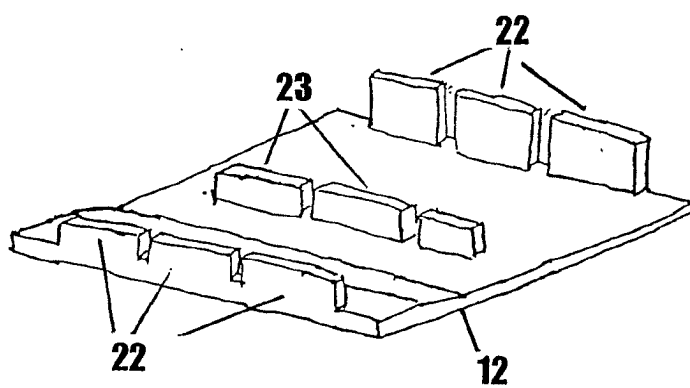


Fig. 2



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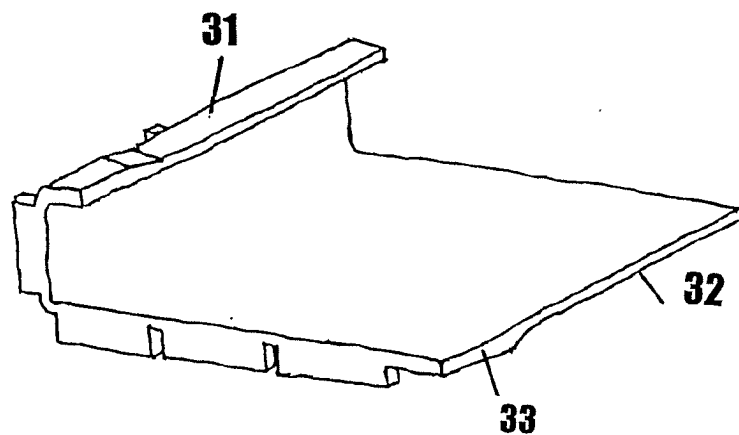


Fig. 3

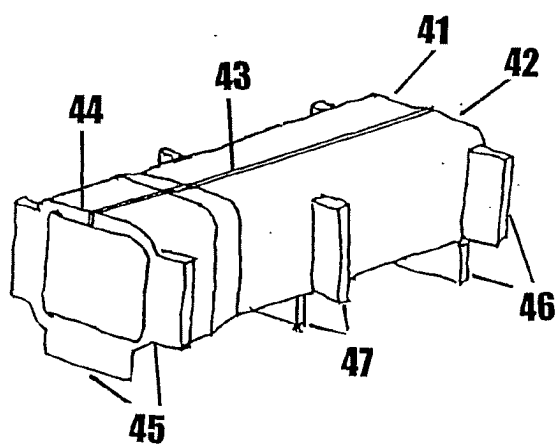


Fig. 4

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/NO 01/00295

## A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B60R 19/34, B62D 21/15, F16F 7/12, B21C 23/14

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B60R, B62D, B21C, F16F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 9814285 A1 (HYDRO RAUFOSS AUTOMOTIVE A/S), 9 April 1998 (09.04.98), figure 4, abstract --	1-6
X	WO 0035610 A1 (NORSK HYDRO ASA), 22 June 2000 (22.06.00), figure 4a, abstract --	1,3-6
X	US 5996645 A (HOSOKAWA ET AL), 7 December 1999 (07.12.99), column 4, line 10 - line 18, figure 5, abstract --	1-3
X	DE 19715308 A1 (BENTELER AG), 22 October 1998 (22.10.98), figure 1, abstract --	1-3

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 19533366 A1 (YMOS AKTIENGESELLSCHAFT INDUSTRIEPRODUKTE), 13 March 1997 (13.03.97), figure 3, abstract --	1-3
X	DE 19829566 A1 (YMOS AG), 18 February 1999 (18.02.99), figure 2, abstract -- -----	1-3

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Information on patent family members

01/10/01

International application No.

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